Policy Pathways to Accelerate Transitions to Zero-Carbon Economies

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Policy Pathways to Accelerate Transitions to Zero-Carbon Economies

We are currently facing three interrelated challenges: Climate change, the COVID-19 induced health and economic crises, and rapid technological development. This contribution outlines how responsible policies for transitioning to a zero-carbon economy can address the climate crisis and offer co-benefits for addressing the other challenges.

The Climate Crisis has become an existential threat to our societies and economies. Climate disasters such as wild fires, droughts, floods, hurricanes and resulting mass migration are increasing and the five warmest years since 1880 occurred in 2015-2019.[1] In 2015 the global international community succeeded in agreeing on the Paris Agreement that for the first time includes all countries, regardless of their state of economic development. The already ambitious target of limiting global temperature increases to 2°C has been replaced by the below-2°C target in response to the plight of small island states and countries with low-lying populated areas to not sacrifice them as sea levels rise in the 2°C scenarios. As of 2019, the observed global temperature change is already in the range of 0.8-1.2°C.[2] Meeting the below-2°C targets requires the decarbonisation of economies by or before 2050 and moving towards net-zero emissions, i.e. compensating remaining emissions with carbon sinks such as trees. For most countries the net-zero by 2050 target[3] necessitates interim targets of reducing emissions by 50% within the next 10 years.

Meeting these targets requires major shifts to the economy and large-scale investments. There will be major challenges for society such as the disappearance of the fossil fuel industries along with related jobs while new industries emerge, making higher investments into life-long learning necessary and creating new green jobs along with re-training employees for the new job opportunities. Billions of USD/GBP/EUR in fossil fuel values will become stranded assets negatively affecting investments and pension funds.[4]

As countries recover from the COVID-19 induced health, financial and economic crises and make new investments, there is also a historic opportunity to focus on zero-carbon and socially inclusive economic development in the form of a 'Green Recovery' to 'Build Back Better' from the ending fossil fuel era. These COVID-19-related crises coincide with major technological change and the availability of clean, zero-carbon technologies not available at competitive prices 10-15 years ago: there is now a strong economic rationale to invest in renewable energies as these are cheaper than fossil fuel infrastructure and technologies, even without subsidies.[5] The removal of direct and indirect fossil fuel subsidies would provide additional financial resources to mitigate negative effects of the zero-carbon transition if these subsidies were re-invested into mitigating adverse social effects (e.g. funding for re-training employees of fossil fuel industries) together with revenues from carbon pricing and thus putting a price on carbon dioxide emissions. 25% of the

1 GISTEMP Team (2020) *GISS Surface Temperature Analysis (GISTEMP), version 4.* (NASA Goddard Institute for Space Studies). Retrieved from https://data.giss.nasa.gov/gistemp/

2 IPCC (2019). 'Global Warming of 1.5°C'. *Special Report.* (Geneva, United Nations) p.6. Retrieved from https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf

3 IPCC (2019): p. 13.

4 Caldecott (ed) (2018) *Stranded Assets and the Environment. Risk, Resilience and Opportunity.* (Routledge).

5 IRENA International Renewable Energy Agency (2019). Renewable Power Generation Costs in 2019. (Masdar, UAE). Retrieved from https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019

commitments under the Paris Agreement could be met by phasing out subsidies alone.[6] However, there is considerable political opposition towards phasing out subsidies. The COVID-19 crisis and related green recovery programmes may provide a window of political opportunity to reduce financial support for fossil fuels. COVID-19 recovery and transitioning to zero-carbon economies to address climate change are part of achieving the Sustainable Development Goals and need to be seen as part of a broader strategy for zero-carbon transitions in the 21st century.

This contribution outlines and discusses how zero-carbon transitions can be achieved and accelerated to rebuild economies in a socially inclusive manner.[7]

UNFCCC negotiations and the Paris Agreement providing a global framework

The Paris Agreement provides the central international legal framework for ambitious climate action on the national level. It follows a 'bottom-up' approach based on countries' Nationally Determined Contributions (NDCs) to reduce greenhouse gas emissions. The focus is on inclusiveness and transparency through regular review mechanisms and the process of increasing ambitions in subsequent NDCs, with the benefit that countries have the opportunity to reflect on each others' policies, draw lessons and engage in mutual learning.[8] This means that over time countries need to become more ambitious in addressing climate change through a positive path-dependency towards stronger climate action.[9] The underpinning logic of this approach is group pressure and scrutiny from the international community[10] coupled with Measuring, Reporting and Verification (MRV) exercises. Countries present their NDCs at UNFCCC meetings, which allows for transparency and comparability of the targets as well as the underpinning policies to achieve the increasingly ambitious climate objectives. The largest advantage of the Paris Agreement over the Kyoto Protocol is that it lacks a deadline by which time commitments should be achieved by developed country parties. This has been replaced by the need for countries to continue to increase their emission reductions every five years amounting to a longer-term trajectory towards net-zero between 2050 and 2100.

The purpose of the UNFCCC negotiations has shifted from negotiating a post-Kyoto Protocol agreement to implementing the Paris Agreement.[11] This means countries need to deliver on their NDCs, i.e. domestic climate policies while increasing ambitions. Only if they are confident they can implement their international targets, they are willing to become more ambitious towards net-zero targets by 2040-2060 in

6 Skovgaard and van Asselt (2020). 'Assessing the impacts of SDGs: The case of fossil fuel subsidy reform'. *Global Goals Conference Paper.*

7 Social inclusion is defined here as a process which "ensures that those at risk of poverty and social exclusion gain the opportunities and resources necessary to participate fully in economic, social, political and cultural life and to enjoy a standard of living that is considered normal in the society in which they live. It ensures that they have greater participation in decision making which affects their lives and access to their fundamental rights"(Commission of the European Communities (2004). Joint report on social inclusion. Brussels: European Commission, p. 9, based on the Charter of Fundamental Rights of the European Union, C326/391, 26.10.2012, retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012P/TXT&from=EN)

8 Rietig (2014). 'Leveraging the power of learning to overcome negotiation deadlocks in global climate governance and low carbon transitions'. *Journal of Environmental Policy & Planning* 21(3): 228-241.

9 Levin, Cashore, Bernstein, & Auld (2012). 'Overcoming the Tragedy of Super Wicked Problems: Constraining Our Future Selves to Ameliorate Global Climate Change'. *Policy Sciences* 45: 123-152. Rietig (2020). 'The Role of Multilevel Reinforcing Dynamics in Negotiating European Renewable Energy Policy'. *Public Administration.* Online first. DOI: 10.1111/padm.12674.

10 Rietig (2014). 'Reinforcement of Multilevel Governance Dynamics: Creating Momentum for Increasing Ambitions in International Climate Negotiations'. *International Environmental Agreements: Politics, Law and Economics* 14(4): 371-389.

11 Chan, et al. (2019). 'Promises and risks of nonstate action in climate and sustainability governance'. *Wiley Interdisciplinary Reviews: Climate Change* 10(3): e572.

line with the below-2°C degree target. This can only be achieved in partnership with civil society, the public, cities and businesses. National-level policies are crucial to set incentives and framework conditions.

The upcoming 26th Conference of the Parties (COP26) will be about finishing the Paris Rulebook, especially Article 6 on carbon markets, raising ambition towards global net-zero emissions by 2050-2080 and inclusion of non-national actors to facilitate the implementation of the Paris Agreement. The inclusion of non-national actors is particularly important to increase resilience of global climate action despite temporary adverse national government policies. Especially transnational networks of cities, sub-national governments, companies and civil society such as 'America's Pledge – we are still in' the Paris Agreement have taken centre stage in the civil society spaces such as during COP23 in 2017. Managing global expectations is key to avoid another failure like COP15 in Copenhagen when the public expected the impossible from the UNFCCC process (where each country has de-facto a veto right). The focus should be on long-term inclusion of non-state actors into implementation networks to share learning, capacity building and raising ambitions. The inclusion of non-state actors can also facilitate learning between countries as well as offer an opportunity for non-state actors and their networks to apply political pressure on the domestic level.[12]

To accelerate global zero-carbon transitions, COP26 offers the opportunity to link existing formal and informal networks and partnerships involving governments and non-national actors into the UNFCCC process. These networks and partnerships will be crucial for the implementation of NDCs. They need to be supported to evolve into inclusive learning and capacity building partnerships that go beyond casual exchanges, virtual presence in an UN database and PR announcements.[13] There is currently a danger that the large number of loose networks results in the illusion of strong bottom-up action while the actual carbon emission reductions remain incremental and temporary.

Effective learning and capacity building partnerships require resources in the form of staff time and long-term commitments to engage in meaningful conversations and reflections about lessons learned, exchange knowledge and experiences of what works in which contexts, allow for the transfer of policies and the celebration of achievements while continually striving for further improvements.[14] Beyond such mutual learning activities around climate action and policies, partnerships need to also allow for capacity building in the form of necessary resources such as access to finance and investment at competitive rates, leapfrogging to install low/zero-carbon technologies and infrastructures as well as specific support for education and a socially inclusive transition. For such partnerships to be successful, it is crucial that actors who are learning and receiving capacity building have a high sense of ownership and understand themselves as a full partner. The most meaningful partnerships include mutual learning about technological, social, economic and institutional contexts regardless of the geographic origin where the learning from experience occurred across the world. Such partnerships bring together different actors from across government, civil society organisations, cities, the private sector and international organisations.

12 Rietig. (2016). 'The Power of Strategy: Environmental NGO Influence in International Climate Negotiations'. *Global Governance* 22(2): 268-288.

13 Long, Clough, and Rietig (2019). *A Study of Partnerships and Initiatives registered on the UN SDG Partnerships Platform.* (New York: United Nations). Retrieved from https://eprint.ncl.ac.uk/file_store/production/261442/A0ECA892-0298-4BD8-882B-03187A900D4E.pdf

14 Cashore, Berstein, Humphreys, Visseren-Hamakers, Rietig (2019). 'Designing stakeholder learning dialogues for effective global governance'. *Policy and Society* 38(1): 118-147.

Implementing NDCs by transitioning to zero/low-carbon economies

Early and decisive action is key to address both COVID-19 and climate change. The policy response needs to be measured and 'make sense' to the public as explaining the scientific evidence and overwhelming scientific consensus behind policy decisions is very important to maintain public support. The policy measures towards net-zero-carbon emissions need to be socially inclusive and focus on economic co-benefits such as green jobs, zero-carbon investment in infrastructure & technologies. They need to be based on a reliable cross-party consensus to ensure trust in long-term investments for transport and energy infrastructure.[15] The environmental, social and economic cost of carbon emissions needs to be reflected in prices and fossil fuel subsidies need to be phased out.

Policy options: the importance of an appropriate instrument mix

A wide range of different policy instruments is available to design the most appropriate climate policy mix adapted to national and local circumstances. Regulation in the form of Command and Control policy instruments sets rules that are backed-up by monitoring and enforcement mechanisms as governments 'command' regulated parties to behave in a certain way by setting e.g. emission standards for air pollutants, product standards, mandating the use of specific technologies to abate pollutants through technology standards or setting up low-emission zones in cities through ambient standards. This dominant and for certain types of pollutants effective approach is increasingly supplemented by subsidies, taxes, market-based instruments and voluntary agreements focused on providing economic and reputational incentives to reduce emissions.[16] These approaches encourage and financially incentivise positive climate action with market signals while discouraging high carbon activities through higher prices and in the case of voluntary agreements reputational risk, while having a lower level of government involvement. Emission trading schemes with and without maximum emission caps, carbon taxes and subsidies for renewable energies fall into this category. 20 carbon markets are active globally in economies accounting for close to 40% of global GDP with another 18 jurisdictions actively considering emission trading.[17] The carbon price ranges from 20-30 USD/t CO2 for emission trading schemes in the EU, New Zealand and South Korea to 5-10 USD/t CO2 for emission trading schemes in the US (California and Regional Greenhouse Gas Initiative covering the New England states and Mid-Atlantic States) and China (pilot schemes in Beijing, Chongqing, Fujian, Guangdong, Hubei, Shanghai, Shenzhen and Tianjin).[18]

Voluntary agreements in the form of public-private or private partnerships and industry-set standards allow for more flexible approaches and leveraging the resources of non-state actors but run the risk of deteriorating into 'green wash' and PR campaigns with limited effectiveness.[19] Monitoring is frequently left to civil

15 Rietig, Laing (2017).' Policy Stability in Climate Governance: The Case of the United Kingdom'. *Environmental Policy and Governance* 27(6): 575-587.

16 Metcalf and Weisbach (2012). 'Linking Policies When Tastes Differ: Global Climate Policy in a Heterogeneous World'. *Review of Environmental Economics and Policy* 6(1): 110-129.

17 ICAP (2019). *Emissions Trading Worldwide: Status Report 2019.* (Berlin: ICAP). Retrieved from https://icapcarbonaction.com/en/?option=com_attach&task=download&id=613

18 ICAP (2020). *Allowance Price Explorer.* Retrieved from https://icapcarbonaction.com/en/ets-prices

19 Van der Ven, Rothacker and Cashore (2019). 'Do eco-labels prevent deforestation? Lessons from non-state market driven governance in the soy, palm oil, and cocoa sectors'. *Global Environmental Change* 52: 141-151.

society organisations with few enforcement options beyond public naming and shaming.[20]

Designing effective NDCs requires a careful evaluation of these policy instruments in the national context. It is important to involve non-state actors in the implementation of the Paris Agreement, but an 'All of Society' approach must carefully evaluate the individual and collective contributions of the various non-national actors and not become overly reliant on voluntary agreements that may run the risk of delivering little more than positive PR and greenwashing. Publicly announced commitments and climate actions of e.g. the private sector need to be regularly verified through independent organisations such as the Carbon Disclosure Project/CDP and fill gaps in regulatory frameworks across e.g. international value chains. Non-national actor contributions also fulfil a crucial role in demonstrating to the national level that ambitious climate action is already under way and would benefit from regulatory support that incentivises climate action while financially or through enforcement penalising adverse behaviour.

Policy stability, integration and coherence

Once effective climate policies are established, they face the risk of being watered down or even abandoned as new governments come into power or shorter-term crises pre-occupy the political agenda and public opinion. This is where policy stability becomes crucial.[21] For policies to be and remain stable, five conditions need to be fulfilled. First, there needs to be a lock-in of the policies via an immediate durability of the policy design. This can be ensured via institutional rules that create hurdles making it immediately hard to reverse the policy, such as constitutional provisions or consensus voting. Second, it also needs to contain self-reinforcing dynamics that increase the costs of reversing the policy the longer it is in place, such as creating vested interests of actors[22] who expect their investments to pay off in the future and would thus object to reversing the policy. Third, there need to be increasing returns with benefits from the policy increasing over time; and fourth, the policy needs to allow for positive feedbacks via expanding to other populations and reinforcing the original support of the population that was initially affected by it.[23] As a fifth condition, adaptability is important to react to new scientific evidence and technologies. Once in place, certain mechanisms can allow for a gradual 'tightening' of the policies without requiring further extensive public and political debate as these policies could be readjusted via executive orders and amendments to the existing legislation. This is important as political feasibility and acceptability for policies is usually higher when they do not require immediate costly action or only demand minor readjustments,[24] but are phased in gradually with increasing ambitions over time as illustrated by the example of the European Emission Trading Scheme or the underlying logic of the Paris Agreement. Automatic review mechanisms and alignment of policy measures with roadmap policies provide further tools to readjust policies that thereby develop a path-dependency towards a lock-in effect into a low/zero-carbon trajectory. Other measures can include the continuous involvement of policymakers in activities that facilitate their learning and change

20 Mason (2008). 'Transparency for whom?: information disclosure and power in global environmental governance'. *Global Environmental Politics* 8(2): 8-13.

21 Rietig (2021). 'Climate Governance in Times of Crisis: Accelerating Low Carbon Transitions via the EU Budget'. *Journal of European Public Policy,* forthcoming.

22 Fraussen. (2014). 'The Visible Hand of the State: On the Organizational Development of Interest Groups'. *Public Administration* 92(2): 406–421.

23 Levin et al. (2012).

24 Betsill and Corell (2008). *NGO Diplomacy: The Influence of Nongovernmental Organizations in International Environmental Negotiations.* (Cambridge, MA: MIT Press).

of underlying beliefs regarding the importance of mitigating climate change as well as raising awareness of policy options to combine climate mitigation and economic development in sustainable pathways. Such policy stability rewards and encourages early adopters, innovators and actors taking on leadership roles. Non-state actors and their networks, transnational alliances and international organisations play an important role in monitoring policy stability and holding governments to account.

There are a number of policy options key to zero-carbon economic transitions. Policy integration and coherence need to be at the heart of the transition. This means that all existing sectoral policies relevant for zero-carbon transitions need to be identified, carefully evaluated in terms of their carbon footprint and adapted accordingly. This policy coherence is crucial to avoid unintended consequences and conflict between policy sectors as other policy objectives may turn out to be mutually exclusive to achieving zero-carbon economies.[25] The policy coherence thus needs to be re-evaluated and if necessary be adapted to emerging new scientific evidence.[26]

Policy sectors and existing opportunities for emission reductions

What socio-economic transitions are required to achieve the below-2°C target? All countries will need to move towards carbon neutrality within the next 30 years in the case of developed countries and within the next 50-80 years in the case of developing countries.[27] Figure 1 illustrates the different sectors and their increasing emission reductions over time for the International Energy Agencies' global Sustainable Development Scenario along a 1.5°C pathway. The measures include increasing energy efficiency in electric motors, buildings, power, light industry, cars and trucks, heavy industry, air conditioners, aviation and shipping (blue), the shift towards renewable energies from wind, solar/PV, biofuels in transport, other renewables in power and end-uses and hydropower (green) as well as some electricity generation from nuclear power and other fuels such as hydrogen (yellow).

Energy-related CO2 emissions & reductions in the Sustainable Development Scenario

World Energy Outlook 2019

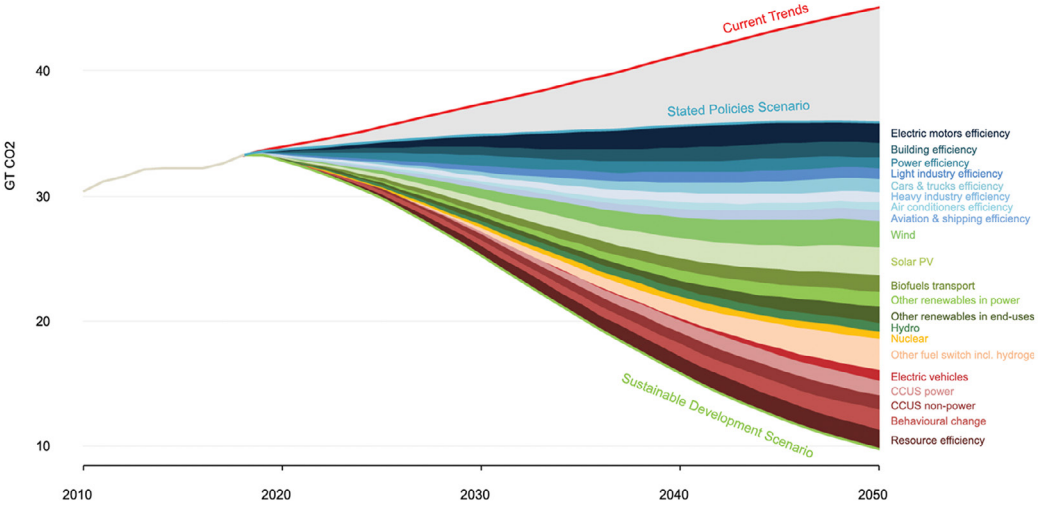

Figure 1. World Energy Outlook 2019.

25 Rietig (2019). 'The Importance of Compatible Beliefs for Effective Climate Policy Integration'. *Environmental Politics* 28(2): 228-247.

26 Rietig (2018). 'The Link between Contested Knowledge, Beliefs and Learning in European Climate Governance: From Consensus to Conflict in Reforming Biofuels Policy'. *Policy Studies Journal* 46(1): 137-159.

27 IEA International Energy Agency. (2019). *World Energy Outlook*. (IEA, Paris). Retrieved from https://www.iea.org/reports/world-energy-outlook-2019

For the European Union and other developed countries, this means achieving 'net-zero' by 2050 in a 'wedge' scenario that includes carbon sinks to remove carbon dioxide from the atmosphere.[28] The most sustainable, low-risk and cost effective approach is protecting existing forestry and re-forestation, requiring sustainable agricultural practices that set aside agricultural land for recovery, greening and biodiversity on a rotating basis, and limiting the expansion of infrastructure/ buildings at the expense of forest cover.

Non-national and transnational action

Non-national actors operating within countries and in transnational settings will inevitably contribute a large share to emission reductions, both directly and indirectly. These include sub-national states, cities accounting for 50% of the global population and 65% of global energy demand, businesses and industry with transnational value chains as well as civil society organisations that advocate and implement behavioural changes. The 'Fridays for Future' youth movement succeeded in raising the climate crisis back to the forefront of many national political agendas and creating a higher sense of urgency among the public. Key initiatives of non-state climate action include, among many others, regional emission trading schemes such as the Regional Greenhouse Gas Initiative of the New England and Mid-Atlantic States of the US[29] and the 'We Are Still In' (the Paris Agreement) coalition representing over 150 million Americans totalling over 9 trillion USD,[30] the Global Covenant of Mayors for Climate & Energy with more than 10,000 cities and local governments from over 135 countries and the 'We Mean Business' coalition with over 1,300 companies who made over 1,900 commitments towards net-zero emissions representing over 24 trillion USD.[31] The UNFCCC Global Climate Action (NAZCA) Portal offers an overview of the number and breath of the ambitions and actions of these non-national actors with over 27,000 actions by over 18,000 actors.[32] These contributions of non-national actors will be crucial to further increase national ambition of NDCs and to cover gaps where national governments are lacking ambition. They send crucial signals to investors, including large institutional investment funds, that demand for fossil fuels is decreasing and divestment will be crucial in the emerging low/zero-carbon economies of the 21st century. Countries increasingly recognise the important role non-national actors play in achieving and strengthening NDCs but there remains large scope to further include non-national actors into NDCs and national climate policies[33] as well as to improve the collaboration between national and non-national actors to more effectively implement climate action.

28 European Commission. (2019). *The European Green Deal.* COM/2019/640final. Retrieved from https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF

29 Regional Greenhouse Gas Initiative. (2020). Retrieved from https://www.rggi.org/

30 We Are Still In. (2020). Retrieved from https://www.wearestillin.com/

31 We Mean Business Coalition. (2020). Retrieved from https://www.wemeanbusinesscoalition.org/

32 UNFCCC Global Climate Action (NAZCA) Portal. Retrieved from https://climateaction.unfccc.int/views/about.html

33 Hsu, Brandt, Widerberg, Chan and Weinfurter. (2020). 'Exploring links between national climate strategies and non-state and subnational climate action in nationally determined contributions (NDCs)'. *Climate Policy* 20(4): 443-457.

New technologies: Artificial intelligence, internet of things & smart applications

There is strong potential that part of the emissions gap between the below-2°C target and the current warming trajectory can be reduced with new technologies using artificial intelligence (AI) applications that are becoming widely available and competitive compared to fossil fuel alternatives. AI is becoming a game-changer for scaling-up the uptake of low-carbon technologies and generating economic growth. Given the current rate of technological development driven by Silicon Valley and the global trends towards integrating information technologies into all areas as well as automation in industry and business, most low-carbon technologies will contain AI as e.g. 'smart electricity grids', 'smart public transport' and 'smart homes'.

While AI promises accelerated technological transitions to achieve climate change objectives, it carries challenges for social cohesion in terms of employment, privacy, cyber security and unintended outcomes e.g. for democracy. We are currently in a phase of experimentation and generating pockets of innovation predominantly on the city level. Many cities are piloting projects on e.g. autonomous (self-driving) vehicles in public transport such as subway trains, electrified bus lanes, zero-carbon emission buildings generating and feeding energy into a smart electricity grid, urban vertical farming and automated recycling systems.

This carries benefits and risks. Key benefits are more efficient use of energy, reducing waste and facilitated uptake through increased convenience, as well as generating economic growth through innovation and technological progress. If not regulated effectively, AI applications however also bring major risks and unintended consequences to society in the areas of employment, privacy and data protection, cyber security and unintended consequences. The increased level of automation is likely to result in large numbers of jobs disappearing in highly qualified areas such as mechanical engineering and lower qualified areas such as logistics/ driving of vehicles. AI is entering all areas of life, including the privacy of the home with AI assistants like Alexa and SIRI as well as smart TVs recording conversations, intelligent fridges keeping track of food use to reduce waste and smart meters sending energy usage to electricity companies. This data is being transferred to the US, China or other countries, dissected by foreign intelligence services and saved indefinitely with privacy settings allowing commercial exploitation of the data. Smart systems bring increased security risks as they can be hacked and hijacked by criminals and used in cyber warfare by other countries, thus increasing vulnerabilities. Early examples range from electricity blackouts during winter in Ukraine to the use of targeted manipulation via Facebook and other social media in the 2016 US elections and the Brexit referendum, thus highlighting the risks to democratic stability and public trust.[34]

Maintaining public support by ensuring socially inclusive transitions

Climate change poses risks to a large number of industries and economic sectors, which are all negatively affected through the consequences of climate change such as droughts, floods, hurricanes/storms, extreme temperatures and rising sea levels.[35] These include small- and large-scale infrastructure such as buildings and road/rail/ shipping transport industries, energy provision through lack of cooling water or damage to energy infrastructure, food provision through the agriculture industry,

34 Moore (2018). *Democracy Hacked. Political Turmoil and Information Warfare in the Digital Age.* (London: One World Publications).
35 IPCC. (2018).

forestry, tourism and cross-cutting issues such as disruptions to supply chains.[36]

Transitioning to low/zero-carbon economies requires large-scale investments and policy stability over a long time horizon into the 2050s and beyond to allow for these long-term investments with life cycles of 20-50 years to pay off. This means that public support must be maintained over a long time period with a focus on policy stability. As in any historic large-scale transition throughout the previous industrial revolutions, not everyone will benefit equally. It is important to recognise that there will be losers of the transition: people working in fossil-fuel relevant sectors such as the oil/gas/coal extraction industries, fossil fuel power plants, the aviation, shipping and automotive industries and large-scale industrial agriculture to name a few. These include low-skilled jobs as well as higher/high-skilled jobs. Investors with assets in these sectors will find that they own 'stranded' assets with losing value if they do not divest fast enough. This will also hit average employees whose pensions are invested in these sectors through large institutional investors given that many of the negatively affected sectors are part of key stock market indices. To maintain overall public support and avoid resentment that could be capitalised on by populist movements and parties into anti-climate action movements and votes (such as recently seen in the United States and Brazil), it is crucial to ensure just transitions that are socially inclusive. This includes compensating the losers of the low/zero-carbon transition by investing into education, public infrastructure and low/zero-carbon industries in cities and rural areas negatively affected by this transition. Fossil fuel-focused companies will have to re-evaluate their business models and start to understand themselves as energy or mobility providers and invest in zero/low-carbon energy provision and mobility technologies. For example, major fossil-fuel focused energy companies acquired renewable energy companies (e.g. Green Star Energy becoming part of Shell in the UK and Innogy SE, which was founded by RWE and acquired by E.ON. in Germany).[37]

Countries need to very carefully re-evaluate their economic systems and move beyond ideological debates to arrive at nationally-adjusted variants of eco-social market economies[38] to combine strong and innovative market economies with social fairness as well as the sustainable use and protection of natural resources in the spirit of sustainable development to meet the Sustainable Development Goals. This includes the importance of social security, accessible high-quality education across all age groups including life-long learning, equal opportunities for all, democracy, accountability, transparency and legitimacy as key elements of good governance. The financial resources required for such a socially inclusive transition could be directly linked to the revenues generated from market-based instruments such as carbon/ eco taxes, emission trading and fines.

36 EEA European Environment Agency. (2016). Report No 1/2017 *Climate change, impacts and vulnerability in Europe 2017.* An indicator-based report. Retrieved from https://www.eea.europa.eu//publications/climate-change-impacts-and-vulnerability-2016

37 E.ON. (2020). *Innogy incorporated into E.ON Group.* Merger squeeze-out completed. Retrieved from https://www.eon.com/en/about-us/media/press-release/2020/2020-06-02-innogy-incorporated-into-eon-group.html. GreenStarEnergy. (2020). *Green Star Energy customers will be transferred to Shell Energy in the next few months.* Retrieved from https://www.mygreenstarenergy.com/Help-and-Support/Moving-to-Shell-Energy

38 Benecke (2008). 'Social and Ecological Market Economy. A General Overview'. In *Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) (ed).* The Social and Ecological Market Economy – A Model for Asia? GTZ, Eschborn: 23-52. Retrieved from https://www.kas.de/c/document_library/get_file?uuid=5453c57d-62e4-5f0b-09a4-8bb040701970&groupId=252038

International cooperation and best-practice learning

On a global scale transitions to low/zero-carbon economies require cooperation and co-ordination to allow for best-practice learning based on experimentation with policy approaches and mixes. This means making use of the opportunities for international cooperation and capacity building offered by international organisations and institutions such as the United Nations and its related programmes and bodies (e.g. UN Development Programme, UN Environment Programme, UN Framework Convention on Climate Change), the World Bank and regional development banks as well as the numerous public-private partnerships and civil society networks. This is particularly important for developing countries recovering from the social and economic damages caused by COVID-19. Recovery plans and partnerships need to recognise and take into account the principle of common but differentiated responsibilities and respective capabilities, in light of different national circumstances and integrate all aspects of sustainable development into national plans for transitions to low-carbon economies. Developing countries have the chance to leapfrog onto a low/zero-carbon development trajectory by choosing new low/zero-carbon infrastructure and technologies instead of repeating the mistakes of developed countries by opting for carbon intensive infrastructures with the accompanying decade-long lock-in into outdated technologies. This however requires the support of developed countries in the form of access to financing (public finance/Green Climate Fund & Multilateral Development Banks and private finance/ leveraging at financial markets), divestment and setting incentives for investment in clean technologies, technology transfer and agreements around intellectual property (WTO) as well as support in the areas of loss and damage (i.e., compensation for countries hit by the consequences of climate change), adaptation and climate-induced migration.

Conclusion

Transitioning to low/zero-carbon economies provides a wealth of benefits while inevitable challenges need to be addressed to maintain public support in a socially inclusive transition. Taking a holistic approach based on the Sustainable Development Goals and international cooperation, mutual learning and capacity building will be crucial. This includes avoiding and mitigating unintended consequences brought on by the challenges of new technologies/Artificial Intelligence and job losses in fossil-fuel based industries while providing carefully designed policy incentives for low-carbon investments to scale up and accelerate the transition. Divesting, removing fossil fuel subsidies and carbon pricing (e.g. cap-and-trade emission trading, carbon tax) can unlock the financial resources required for a socially just transition. Countries can ensure successful COVID-19 recoveries through low/zero-carbon economic transitions and the necessary policy stability by embedding climate policies across sectors, building policy resilience to financial/economic/health/political crises, incentivising non-state actor contributions and adhering to ambitious long-term targets towards 2050 and beyond.

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